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54 **Reversible motor.**

57 A reversible linear motor has a coil arrangement (11) arranged alongside a conductive body such as a rotatable aluminium disc (6). The coil arrangement (11) is made up of three separate coils: namely an inner coil (13) and two inter-connected outer coils (12, 14) on opposite sides of the inner coil (13). The coils (12, 13, 14) are connected to a single phase a.c. supply (L,N) and the drive of the disc (6) can be reversed by reversing the connection of the inner coil (13) relative to the two outer coils (12, 14).

The linear motor may be used for driving a reel (1) of an entertainment machine of the fruit machine kind.

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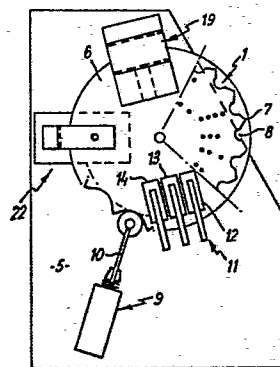


Fig. 3

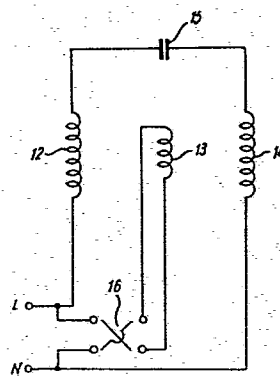


Fig. 5

(EP12616)
(9.10.80)

- 1 -

REVERSIBLE MOTOR

This invention relates to a reversible linear motor.

- The motor of the invention may comprise a member
5. which is mounted on a support structure so as to be rotatable relative thereto through a plurality of predetermined stopping positions; and the invention is particularly concerned with such a rotatably mounted member which is a reel assembly of a coin-freed
 10. gaming-type entertainment machine of the kind known as a fruit machine, that is, a rotatably mounted member in which the member is a drum or disc (or reel) which in use is provided with a plurality of symbols, such as fruit, around the periphery thereof and can
 15. be rotated for a period of time and then brought to rest at one of say 20 stopping positions thereof to display in such stopping position one or more of said symbols. A fruit machine usually has three or four such reels whereby in use, during play of a game, the
 20. reels may rotate for different random periods of time and display when stopped a randomly selected combination of symbols; and a position identifying system is used to provide a machine interpretable identification of the selected symbols whereby a win mechanism such as
 25. a pay-out device can be actuated in the event that the displayed combination of symbols corresponds to a predetermined winning combination.

In our co-pending U.K. Patent Application No. 2035648

(EP12616)
(9.10.80)

- 2 -

- there is disclosed a rotatably mounted member comprising a member which is mounted on a support structure so as to be rotatable relative thereto through a plurality of predetermined stopping positions, an electrical drive motor being provided for effecting said rotation of the member, and indexing means being provided for stopping the member in one of said stopping positions thereof, characterised in that said drive motor is an integral part of the rotatably
5. mounted member. In one embodiment of the invention described in such Application, the drive motor is a rotary linear motor having a metal rotor in the form of a disc or cylinder and a fixed coil structure which is positioned alongside a surface of the rotor
10. and in use generates a magnetic field moving in the plane of such surface, said coil structure having two coils one of which is fed directly from an a.c. supply and the other of which is fed from such supply via a capacitor whereby by reversing the connection of one
15. coil it is possible to reverse the direction of rotation of the rotor. Such reversing of the rotor is required in the context of a fruit machine in the case where there is a reverse 'nudge' facility, i.e. where a control is provided for causing a stationary
20. drum or disc to step backwards from one stopping position to the next successive stopping position.

With the arrangement of the above mentioned embodiment problems may be encountered with regard to obtaining

30. equal torque in both forward and reverse directions of rotation with a simple and efficient structure, due to the change in mutual inductance produced by the coil reversal.

35. An object of the present invention is to provide a

(EP12616)
(9.10.80)

- 3 -

simple and efficient reversible linear motor with which it is possible to achieve substantially equal driving forces in both directions of drive thereof.

5. According to the invention therefore there is provided a reversible linear motor comprising a coil arrangement and a conductive body which are mounted so as to be movable one relative to the other, characterised in that the coil arrangement has three
10. separate coils disposed adjacent the conductive body: namely a pair of interconnected coils spaced from each other in the direction of said relative movement of the body and the coil arrangement, and a third coil between the pair of coils, the coils being arranged
15. for connection to a single phase a.c. supply, and reversing means being provided for reversing the connection of the third coil, or the interconnected pair of coils, relative to the supply.
20. In one embodiment the two outer coils are substantially identically wound coils of opposite hand interconnected via a tuning capacitor to give a singly tuned pair, and the central coil is predominantly inductive, whereby the magnetic fluxes of the two outer
25. coils are anti-phase to each other (180° apart) and the phase of the magnetic flux of the central coil lies between the outer coils (spaced by 90° from each coil). With this arrangement the pair of singly tuned outer coils are balanced magnetically about the single central
30. coil so that reversal of mutual inductance due to reversal of the central coil (or reversal of the outer coils) cannot detune the coil pair. Thus, even in a system with high mutual inductance it is possible to achieve equal torque in opposite driving directions with
35. a simple and efficient arrangement.

(EP12616)
(9.10.80)

- 4 -

Most preferably the said conductive body comprises a rotatable member as hereinbefore described.

The invention will now be described further by way of
5. example only and with reference to the accompanying drawings in which:-

- Fig. 1 is a diagrammatic perspective view of one form of a fruit machine incorporating
10. motors in accordance with one embodiment of the invention;
- Fig. 2 is a diagrammatic plan view (with parts omitted for the sake of clarity) of one reel assembly of the fruit machine of Fig. 1;
15. Fig. 3 is a diagrammatic end view of the reel assembly of Fig. 2;
- Fig. 4 is a block circuit diagram of a control system of the machine; and
- Fig. 5 is a circuit diagram of the coil arrangement of one linear motor drive of the machine.
20.

The fruit machine has a cabinet 30 containing three reels rotatable behind a window 31 and having control buttons 32, a coin or token inlet slot 33 leading to
25. an internal coin-freed mechanism and an outlet chute 34 leading from an internal pay-out mechanism. Each reel comprises a drum 1 which may be formed from plastics material and has one circular end wall 2 and a cylindrical peripheral wall 3.

30.

The drum 1 is secured to an axially extending central boss 4 which is rotatably mounted on a shaft fixed on a support structure 5. This structure 5 may be in the form of a rigid metal plate extending parallel to the
35. wall 2 of the drum 1. Within the drum 1, an aluminium

(EP12616)
(9.10.80)

- 5 -

- disc 6 is fixed on the shaft 4 and extends parallel to the end wall 2. The disc 6 as shown in Fig. 3 has 20 V-shaped teeth 7 cut at regular intervals around its entire periphery, 20 V-shaped cut-outs 8
5. being defined between the teeth 7. An electromagnetic indexing device 9 is mounted on the support structure 5 and this device has a solenoid operated catch finger 10 with a roller at the end thereof which is normally held spaced from the teeth 7 so as to permit free
10. rotation of the disc 6 but which can be moved forwards, on de-energisation of the solenoid of the device 9, to engage a cut-out 8 between two teeth 7 and thereby prevent rotation of the disc 6.
- A coil arrangement 11 is also mounted on the support
15. structure 5 adjacent the disc 6. The coil arrangement 11 comprises three separate coils 12, 13, 14 disposed within the confines of the drum 1 and spaced in the circumferential direction of the disc and each having a respective U-shaped laminated metal core straddling
20. the disc. The free ends of the U-shaped cores define poles facing each other and between which the disc can rotate. The laminations of the cores have splayed-out ends at such poles thereby to increase the effective surface area thereof which confronts the disc. The
25. two outer coils 12, 14 are similarly wound coils of opposite hand and are interconnected via a capacitor 15 to define a singly tuned coil pair which is connected across a single phase a.c. supply. The central coil 13 is connected to the same supply via
30. a reversing switch. The magnetic fluxes in the coils 12, 14 are 180° out of phase, and the magnetic flux in the predominantly inductive central coil 13 is spaced by 90° from the fluxes in both coils 12, 14. The coil arrangement 11 and the disc 6 therefore define a single
35. phase short rotary linear motor. The disc 6 is urged

(EP12616)
(9.10.80)

- 6 -

- in one particular direction. By reversing the connection of the coil 13 with the switch 16, the direction of rotation of the disc 6 can be reversed. Since the coils 12, 14 are balanced magnetically about the coil 13 reversal of the coil 13 does not detune the pair 12, 14. A permanent magnet arrangement 19 is also mounted on the structure 5 alongside the disc 6, such arrangement having two magnets with North and South poles thereof facing the side of the disc adjacent the drum 1 and a U-shaped metal stirrup 20 which straddles the disc and provides a flux return plate on the opposite side of the disc. Rotation of the disc gives rise to induction of eddy currents therein due to the action of the magnet and the resulting magnetic field interacts with the magnetic field of the magnet to resist rotation of the disc. The rotational speed of the disc 6 is thereby limited.

- The reel assembly so far described is mounted together with other like reel assemblies in the fruit machine cabinet 30. In use, after insertion of one or more coins or tokens into a coin mechanism via the slot 33, a player can operate the machine to set the drums of the reel assemblies in rotation. When the drums 1 are brought to rest, after different random periods of rotation, with the indexing devices 9, the positions of the drums 1 are detected with code-reading devices 22 which use light sources 21 and sensors 23 on opposite sides of the discs to scan coded arrangements of holes therein and as described in greater detail in, for example, U.K. Patent Application No. 7936290. Electrical outputs from the code-reading devices are interpreted with a win detection system and pay-out mechanisms are actuated in the event that a winning combination of drum stopping positions is detected.

(EP12616)
(9.10.80)

- 7 -

- As shown in Fig. 4, the machine incorporates electronic control circuitry which uses a central processing unit such as a microprocessor MPU which has connected thereto appropriate processor power supply
5. and auxiliary control devices 35, memory devices 36 and an input/output interface device i/o. The interface device i/o is connected to input devices 37 such as the controls and the coin mechanism and output devices 37 such as pay-out solenoids, indicator lamps
 10. and the like. The interface device i/o is also connected to the position identifying system of the different reel assemblies and also the indexing mechanisms 9 and the reversing switches 16 thereby to control operation of such mechanisms 9, switches 16 and
 15. also to interpret and evaluate position identifying and indexing data. For a further description of suitable electronic circuitry reference is made to U.K. Patent 1,545,301.
20. It is of course to be understood that the invention is not intended to be restricted to the details of the above embodiment which are described by way of example only.

(EP12616)
(9.10.80)

- 8 -

Claims:

1. A reversible linear motor comprising a coil arrangement and a conductive body which are mounted so as to be movable one relative to the other,
5. characterised in that
the coil arrangement has three separate coils (12,13,14) disposed adjacent the conductive body (6): namely a pair of interconnected coils (12, 14) spaced from each other in the direction of said relative movement of
10. the body and the coil arrangement, and a third coil (13) between the pair of coils, the coils being arranged for connection to a single phase a.c. supply, and reversing means (16) being provided for reversing the connection of the third coil, or the interconnected
15. pair of coils, relative to the supply.
2. A motor according to claim 1, characterised in that
the conductive body is an axially rotatable metal
20. disc (6).
3. A motor according to claim 1 or 2, characterised in that
the two outer coils (12, 14) are substantially
25. identically wound coils of opposite hand interconnected via a tuning capacitor to give a singly tuned pair, and the central coil is predominantly inductive, whereby the magnetic fluxes of the two outer coils are anti-phase to each other (180° apart) and the
30. phase of the magnetic flux of the central coil lies between the outer coils (spaced by 90° from each coil).
4. A motor according to any one of claims 1 to 3, characterised in that
35. each coil (12, 13, 14) has a core straddling the conductive body (6).

(EP12616)
(9.10.80)

- 9 -

5. A motor according to any one of claims 1 to 4, characterised in that a magnet (19) is positioned alongside the disc (6) to clamp rotation thereof.
- 5.
6. A coin-operated entertainment machine having a plurality of members mounted on a support structure so as to be rotatable relative thereto through a plurality of predetermined stopping positions, means
10. operable to effect said rotation and subsequently to cause the members to stop in ones of said stopping positions, and an electrical position identifying system for identifying said ones of said stopping positions,
15. characterised in that for each said member there is provided a reversible linear motor for driving same, said motor comprising a coil arrangement (12,13,14) and a conductive body (6) which are mounted so as to be movable one relative to
20. the other and thereby effect rotation of the said member, and wherein the coil arrangement has three separate coils (12,13,14) disposed adjacent the conductive body (6): namely a pair of interconnected coils (12,14) spaced from each other in the direction of said relative
25. movement of the body and the coil arrangement, and a third coil (13) between the pair of coils, the coils being arranged for connection to a single phase a.c. supply, and reversing means (16) being provided for reversing the connection of the third coil, or the
30. interconnected pair of coils, relative to the supply.
7. A machine according to claim 6, characterised in that for each member said conductive body (6) comprises an
35. axially rotatable disc separate to but directly drivably

(EP12616) - 10 -
(9.10.80)

connected to the said member.

8. A machine according to claim 7, wherein indexing means is provided for stopping the member in any of
5. the said predetermined stopping positions thereof characterised in that said indexing means (9) comprises retaining means inter-engageable with the disc (6).
10. 9. A machine according to claim 7 or 8, characterised in that said position identifying system (27) is adapted to read position identifying structures on said disc (6).

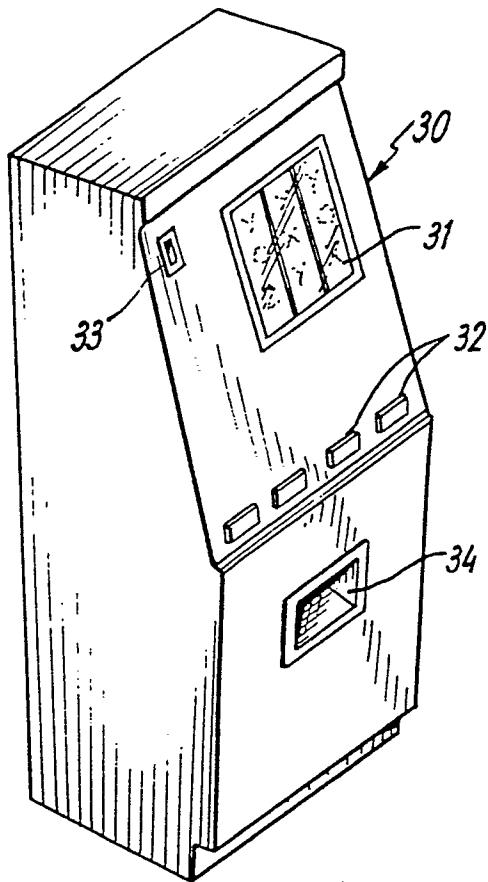


FIG. 1

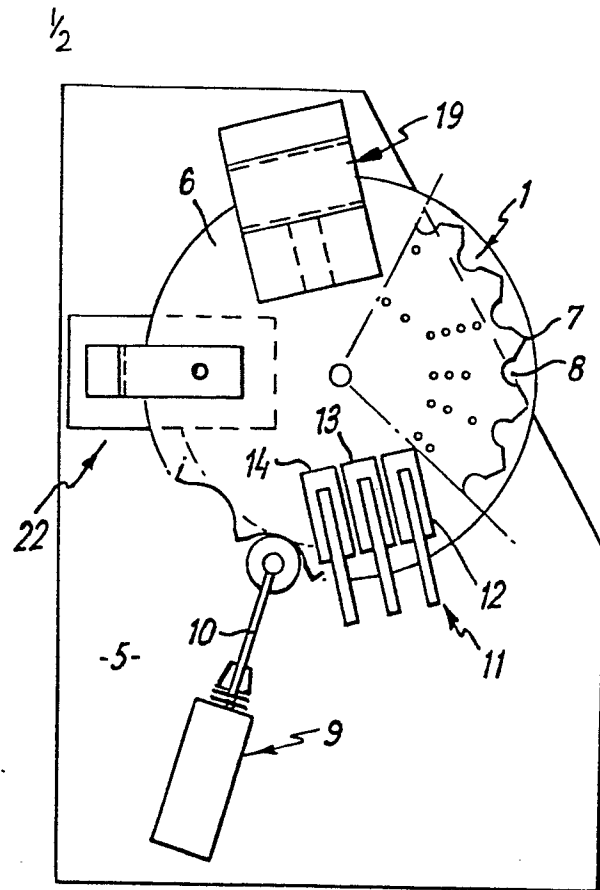


FIG. 3

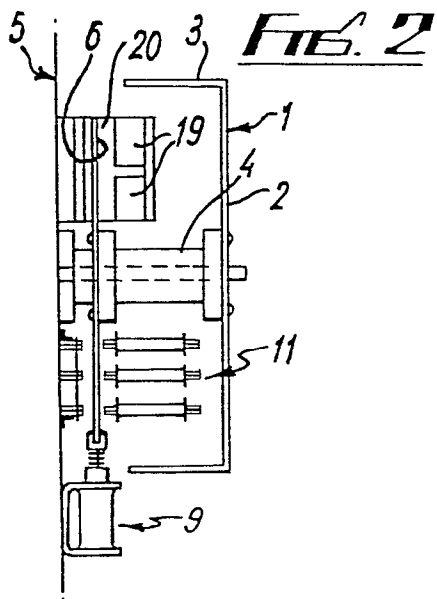


FIG. 2

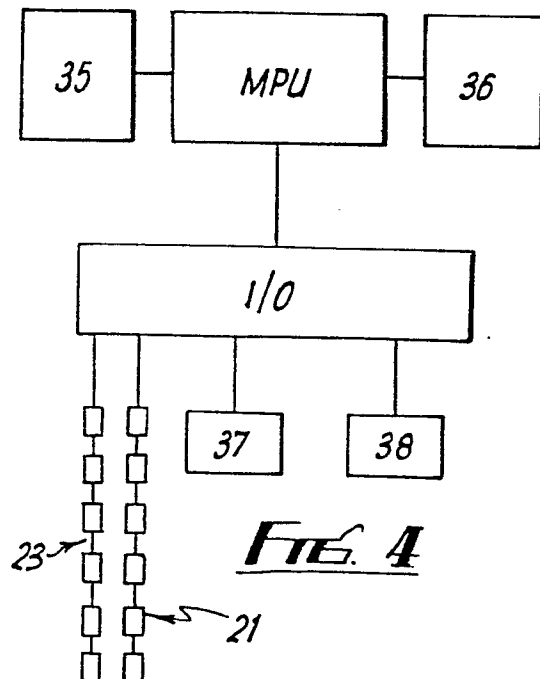


FIG. 4

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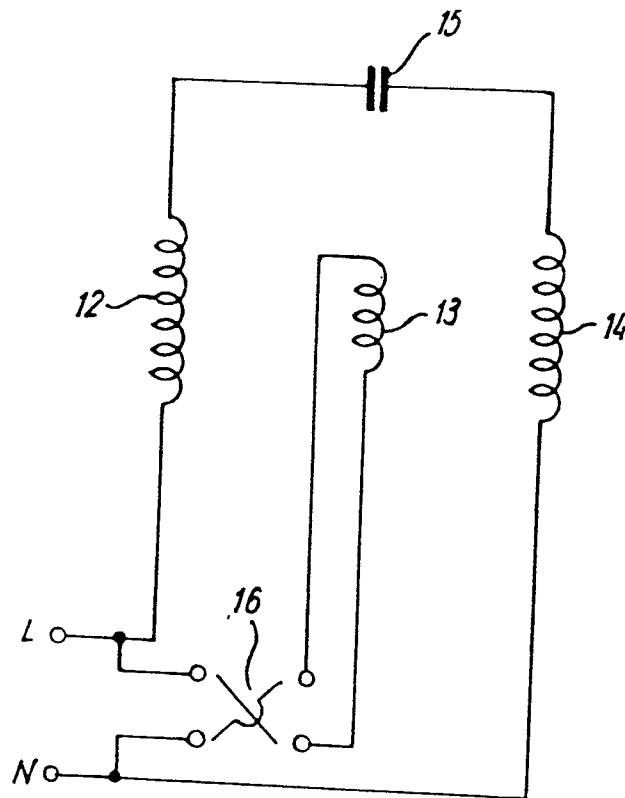


FIG 5



DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	DE - C - 892 157 (HINTZE) * Page 2, lines 23-41; figures 1,2 *	1,2,4,6,7	H 02 K 41/025 H 02 P 7/00 H 02 K 17/08 G 07 F 17/34
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	US - A - 1 893 377 (ROSE) * Page 1, lines 79-100; page 2, lines 1-72; figures 1,2,7 *	1,3	
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	US - A - 4 037 845 (HOOKER) * Column 9, lines 40-57; figure 11 *	5,8	TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
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	LU - A - 80 399 (GUNTER WULFF) * Page 17, lines 8-23; page 18, lines 1-21; figures 1-4 *	9	H 02 K 41/025 41/02 17/08 17/04 17/30 H 02 P 7/00 1/40 G 07 F 17/34
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EP	EP - A - 0 011 395 (SUREVILLE LTD) * Page 13, lines 25-35; page 14, lines 1-7; claims 1-13; figures 1-5 *	1-9	
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A	BE - A - 501 152 (CLOTWORTHY)	1	CATEGORY OF CITED DOCUMENTS
A	US - A - 3 216 226 (ALGER et al.)	1	X: particularly relevant
A	US - A - 3 194 032 (VON BRIMER)	1	A: technological background
A	US - A - 3 561 724 (TROMBETTA)	1	O: non-written disclosure
A	FR - A - 1 476 328 (SIEMENS-SCHUCKERT)	1	P: intermediate document
A	DE - A - 2 256 893 (STEININGEN)	1	T: theory or principle underlying the invention
	./.		E: conflicting application
			D: document cited in the application
			L: citation for other reasons
			&: member of the same patent family, corresponding document
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
The Hague	16-01-1981	TIO	



European Patent
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EUROPEAN SEARCH REPORT

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Application number

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DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	FR - A - 2 001 736 (PAPALEONIDAS) -----	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl. 3)